

Approved by:

_____/_____/_____
Process Engineer_____/_____/_____
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1 SCOPE

The purpose of this document is to detail the creation of stepper jobs for the ASML PAS 5500. All users are expected to have read and understood this document. It is not a substitute for in-person training on the system and is not sufficient to qualify a user on the system. Failure to follow guidelines in this document may result in loss of privileges.

2 REFERENCE DOCUMENTS

Batch Control PAS 5500 Training Module
Reticle Design Manual
PAS 5500 User Guide
PAS 5500 Job Definition
PAS Global Alignment Strategies
PAS 5500 Steppers up to and including /300 Stepper Introduction

3 INTRODUCTION

3.1 Overview - These instructions provide an overview of creating stepper jobs for the ASML PAS 5500/200. Up to 30 layers can be done in a single job. In a job, **Wafer Layout** will define how the die are arranged on the wafer and **Layer Layout** will define the details of each layer. The maximum square field size on the wafer is X=22mm and Y=22mm.

3.2 Information Needed to Write a Job

- 3.4.1 Cell Size – This is the step size of the reticle image on the wafer, including streets.
- 3.1.2 Number of Die per Cell
- 3.4.3 Number of Levels
- 3.4.4 Image Size – This is the reticle image on the wafer.
- 3.4.5 Location and number of alignment marks

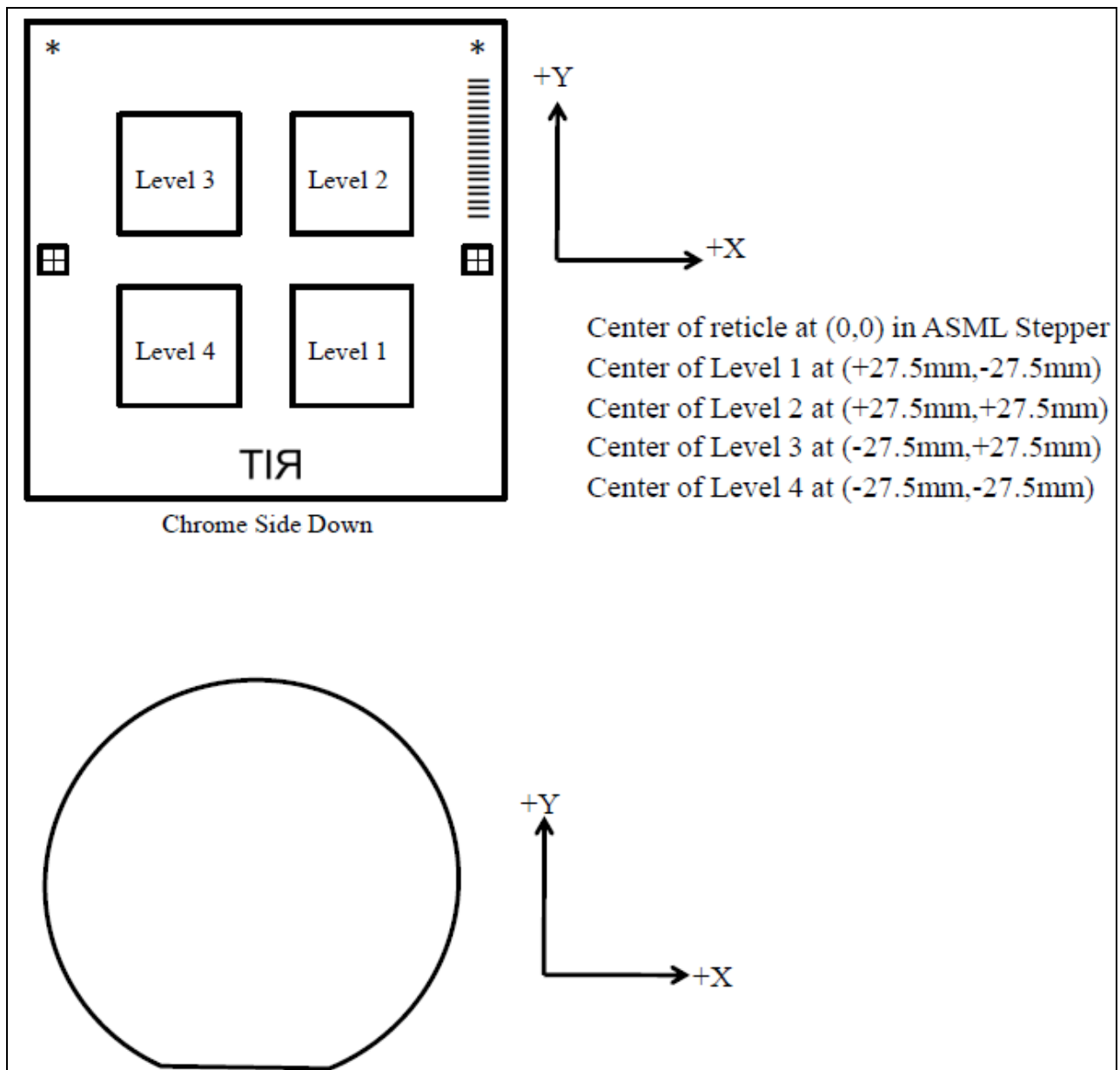


Figure 1. Sign conventions on the ASML Stepper. Shown at top is the standard SMFL multiple field array, chrome side down, with the center of the reticle at (0, 0).

4 RETICLE ALIGNMENT TO A WAFER

- 4.1 **Global Alignment** - The wafer alignment marks W1, W2, etc, are exposed on the zero layer and etched into the wafer. Two of these marks are sufficient but up to 25 may be used on a single wafer. If more than two marks are used, the stepper will find a best alignment and expose all die using the same settings. The stepper uses through the lens alignment of the wafer to the reticle alignment marks.
- 4.1.1 The **PM Mark** is a square that is divided into 4 quadrants with horizontal and vertical gratings. It is used for Global Alignment. This mark is relatively large and may take up valuable die space. This mark is available for exposure from the **Combi Reticle**.
- 4.1.2 The **SPM Marks** are narrow enough to fit in the dicing streets, and consist of separate marks for the X-direction and Y-direction. These marks could be included in a mask design or exposed from a separate reticle.
- 4.2 **Field by Field Alignment** - This method uses marks that are part of the CAD data for each mask layer; they are typically not exposed individually. These marks may be placed in the scribe lanes. Field by field alignment takes longer than global alignment because each die is aligned, but provides more accurate overlay between layers. For more information consult the ASML Reticle Design Manual.

5 CREATING A NEW STEPPER JOB

- 5.1 From the Main Menu select 4 – Job Definition and then 1 – Modify Job.
- 5.2 Type in a **Job Name** that has not already been used and hit return. Spaces are *not* allowed in a job name. Your **Job Name** should include either your name, project number or class name.
- 5.3 The displayed settings are default values that are determined by the factory constants.
- 5.4 Fill out the comment section with information about your job. Be sure to include your name and project code.
- 5.5 Select **Accept** when done.

6 MODIFYING A STEPPER JOB

- 6.1 When working on a stepper job use the **Enter** key after changing a parameter. The **Accept** button will accept the settings in the window and return to the previous page. If an **Apply** button is present, it should be selected to confirm any changes.
- 6.2 To modify an existing job click **Select**, scroll down to the job, click on the job and then click **Accept** at the top.
- 6.3 **Wafer Cell Layout** – This section is where the step size of the reticle image on the wafer is input. This step determines the number of cells, the street size and the how the cells are placed relative to the center of the wafer. Each cell may contain more than one die. The details of individual reticle images will be defined later.
- 6.3.1 Select **1 – Wafer Layout** from the **Job Contents** menu.
- 6.3.2 Select **1 – Cell Structure**.
- 6.3.3 Under **Dimensions**, enter the **Cell Size** at the wafer level in mm, including the dicing streets.
- 6.3.4 Under **Die Definition** enter the number of die per cell in the x and y directions. Under **Wafer Cover** choose **W** for **Whole Wafer Cover** to expose the entire wafer surface except the flat or **I** for **Inner Wafer Cover** to expose only within the round and flat edge clearance.
- 6.3.5 Under **Cell Matrix**, selecting **C** for **Placement Mode** will use a computer fit to optimize the number of die on a wafer. Selecting **O** will allow the operator to shift the die manually using the **Matrix Shift** function. A matrix shift of zero centers a cell on the wafer. Use **Preview Results** to view the graphic.
- 6.3.6 Remember to **Enter** each value and to **Accept** when finished. The layout grid will now be displayed.
- 6.4 **Alignment Definition** – This section will define how wafers are aligned and the coordinates of the Global Alignment marks on the wafer. Marks should not be placed closer than 5mm from the edge of the wafer. A minimum of 2 marks is required.
- 6.4.1 Select **2 - Alignment Definition**.
- 6.4.2 Select **2 - Optical and Global Alignment** to place alignment marks.
- 6.4.3 Enter a **Mark ID** for the 1st mark (any alphanumeric character or just number them). Select the **Mark Type**. The default is Primary Mark or **PM**. To select a

different type, select the line next to **Mark Type** and choose the desired mark from the list. If not using a standard mark available on the **Combi Reticle**, the image size and position will have to be defined manually using the **Mark Position** section.

- 6.4.4 Select **C** for cell coordinates under **Mark Specification** to allow the cell coordinates in mm to be specified. Alternately **W** could be selected to specify in wafer coordinates with the center at (0,0).
- 6.4.5 Under **Cell Index** enter the coordinates for the 1st mark and the **Mark to Cell Shift**. The center is at (0,0). With the flat down, positive x is to the right of the origin and positive Y is above the origin. The marks must be within the shaded areas on the wafer map.
- 6.4.6 Select the **Apply** button.
- 6.4.7 Select the **New** button.
- 6.4.8 Enter a **Mark ID** for the 2nd mark and complete steps 6.4.4 through 6.4.6.
- 6.4.9 Repeat the steps above if more than 2 marks are needed. If using SPM marks in the scribe lanes, the marks for the x and y directions will be separate, requiring a minimum of 4 marks to be placed.
- 6.4.10 **Exit** when finished back to the **Wafer Layout Menu**.
- 6.5 **Alignment Strategy** – This section allows the selection of which marks to use for alignment and whether they are primary or backup. It is possible to define several different strategies to choose from.
 - 6.5.1 Select **3 – Alignment Strategy**
 - 6.5.2 Enter an **Alignment Strategy ID** (a number works ok) and select **TTL** under **Wafer Alignment Method**.
 - 6.5.3 Select **Apply**.
 - 6.5.4 To set up the marks to be used for alignment, choose **Selection**.
 - 6.5.5 To select all of the defined marks, enter * and * under **Mark ID** and then **Add**. **Exit** out when done.
 - 6.5.6 To select individual marks, enter in a **Mark ID** (same used in **Alignment Definition**) and select the **Usage** and **Mark Preference** (preferred or backup) and

then **Add**. Repeat for each mark. **Exit** out when done. A minimum of two marks are required. The total number of marks will show up next to **Number of Marks to Align**.

6.5.7 Marks may be deleted by entering a **Mark ID** and then selecting **Delete**.

6.6 **Mark Clearout** – For some layers it may be beneficial to flood expose the PM marks so that oxide or other materials may be removed during an etch step.

6.6.1 Select **4-Mark Clearout**

6.6.2 Select **Y** next to **Mark Clearout**.

6.6.3 Make sure the **Default Reticle ID** is **45024001A226** for the **Combi Reticle**.

6.7 **Reticle Image Definition** – This section is where the reticle ID's and blade settings are specified to define an image. Each level including the PM marks will have at least one image. Image size is specified at the reticle level and the computer determines the appropriate blade settings. If there are multiple levels on one reticle, the image shift function can be used to define the different levels on the reticle.

6.7.1 Select **3 - Image Definition**

6.7.2 For each image enter an **Image ID**, a **Reticle ID** (manually enter if there is no bar code on the reticle) and an **Image Size** for each image. The **Image Size** can be entered at the **Wafer** or **Reticle** level. The maximum square image size on the wafer is 22x22mm. If necessary enter an **Image Shift**. An image shift would allow for more than one level on the same reticle. See **Figure 1** for sign conventions when determining shifts.

6.7.3 Additional images may be added by selecting the **New** button.

6.7.4 Remember to **Apply** the changes and **Exit**.

6.8 **Image Distribution** – This section is used to specify where reticle images go on the wafer. It is possible to expose multiple images on the same layer. Images may be shifted within a cell or deleted.

6.8.1 Select **4 - Image Distribution**.

6.8.2 Select an **Image ID**. Type a * in both the **X** and **Y** field of **Cell Index**. Select **Apply** and **Draw Wafer**; the images will be displayed in the grid.

- 6.8.3 To drop out an image enter the coordinates of the cell to be dropped out in the **Cell Index**. Select an Image ID from the list. Click **Delete** and **Draw Wafer**; the images will be displayed in the grid. This may need to be done for each **Image ID**. Deleted cells may be replaced by entering in the coordinates and selecting **Apply** and then **Draw Wafer**. Make sure to drop out images that occur over alignment areas. An entire row or column may be dropped by using a * in either the **X** or **Y** field of the **Cell Index**.
- 6.8.4 An image may be shifted relative to the cell grid by entering a Image to Cell Shift.
- 6.8.5 **Exit** and then **Exit** again to the **Job Contents Window**.
- 6.9 Layer Layout – This section is used** to select the number of layers and to define the layer ID for each layer. It is possible to have multiple layer IDs for a single layer.
- 6.9.1 Select **2 – Layer Layout** from the **Job Contents Menu**.
- 6.9.2 Select **1 - Layer Definition**.
- 6.9.3 Enter the number of layers.
- 6.9.4 Select **Next** to toggle between layers or **New** to define a new layer.
- 6.9.5 Under **Layer ID** enter the number.
- 6.9.6 **Apply** and **Exit**.
- 6.10 Global Alignment Marks Exposure – This section is used** to select the alignment marks for each layer. It is possible to expose a mark and an image on the same layer. As a default all defined marks are exposed in zero layer and used to align to in all subsequent layers.
- 6.10.1 Select **2 - Marks Exposure**.
- 6.10.2 Next to **Layer** select 0 layer. Next to **Mark** select a mark and then **Y** next to **Mark Exposure**. Repeat for all marks.
- 6.11 Process Data –The zero layer and the first layer may be combined** in this section, but this will result in less overlay accuracy because the first layer will only be pre-aligned.
- 6.11.1 Select **4-Process Data**

6.11.2 Under **Layer** select **Next** to get to **layer 1**. Select **No** next to **Combined Zero/First Layer** to separately expose the zero and 1st layer.

6.11.3 Repeat for additional layers

6.11.4 A **Layer Shift** in microns can be introduced.

6.11.5 **Apply** and **Exit**.

6.12 Reticle Data – This section is used to define exposure energy, focus and illumination method.

6.12.1 Select **5-Reticle Data**

6.12.2 For each layer and image choose a **Reticle ID**.

6.12.3 To toggle between layers and images select **Next**.

6.12.4 For each layer *and* each image under **Expose Image**, choose **Y** or **N** to expose or not to expose that particular image. *Depending on how the job is set up, it may default to exposing multiple images on a particular layer.* It is important to check all images and layers. Note that in some cases it may be necessary to expose multiple images on a layer.

6.12.5 For each image that you will expose choose the energy, focus, tilt, illumination mode, NA and sigma.

6.12.6 **Apply** and **Exit**.

6.13 Saving a job

6.13.1 In **Layer Layout** click **Exit**.

6.13.2 In **Job Contents** click **Exit**.

6.13.3 You will be given the option to save, discard or continue editing the job.

R.I.T**Title: ASML PAS 5500 Job Creation****Semiconductor & Microsystems****Fabrication Laboratory****Revision: E****Rev Date: 04/27/2020****REVISION RECORD**

Summary of Changes	Originator	Rev/Date
Original Issue	Sean O'Brien	A-08/05/2010
Modified 6.4.3, 6.5 and 6.6 added, 6.8 rearranged to clarify; other areas had minor corrections and clarifications, added Figure 1.	Sean O'Brien	B-12/07/2010
Updated Fig. 1 to reflect SMFL multiple field array, updated Combi Reticle barcode	Sean O'Brien	C-05/30/2012
Expanded 6.5 Alignment Strategy	Sean O'Brien	D-09/20/2012
Expanded 6.8.3 to drop entire row or column, improved wording in some areas and fixed mistakes	Meller/O'Brien	E-04/27/2020